Final Report for SSEP Project P0775007
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Report date, September 2008

PISCES II Model Simulation of Oil Spills and Protection Strategies

During the 2007/2008 fiscal year modelers Dr. Phil Arms and Mr. Mike Noonan at the California Maritime Academy developed oil spill simulation models of booming protection strategies for five California coastal environmentally sensitive site locations. In order from north to south they were: Inner Humboldt Bay; Bolinas Lagoon entrance; Elkhorn Slough entrance; Morro Bay entrance; and Newport Harbor entrance. For each of these sites one or more protection strategies were selected by the local Environmental Scientist familiar with the location, along with a set of physical parameters and an oil type for the CMA modelers to utilize in evaluating the effectiveness of that respective strategy. The overall task proved to be quite challenging at some of the sites due to a dearth of water current data. For those sites the modelers were required to develop their own "best estimate" of current velocities for given tidal parameters. For each site a video simulation was generated depicting the movement of oil, and the potential effectiveness of the prescribed protection strategy. Copies of the final products were distributed to the respective ES's to share with their Area Committee's.

The purpose of this effort is to evaluate variations and outcomes of protection strategies in an effort to determine if proposed strategies might have a reasonable chance of success before an actual oil spill response may be required. The long term concept of this project is to re-visit these (and other sites) in future projects to re-work protection strategies and physical parameters in order to explore improvements in oil spill response results. The newly developed baseline simulations will provide the necessary tool from which to explore new response strategy concepts. As better physical parameter data are developed they too can be incorporated into the models.

The simulation summaries provided below represent our first attempt to utilize the relatively new, and always evolving PISCES II simulation software in a "preemptive" manor to evaluate the likely success of a number of the currently published Area Contingency Plan protection strategies. In light of the unfortunate outcome of the Bolinas Lagoon boom protection effort during the *Cosco Busan* spill response, it is evident that we should be utilizing every available means to evaluate the numerous potential actions and outcomes that may occur at any of the many environmentally sensitive sites along the California coastline.

The following summaries represent a generalized description of the simulation effort for the five sites evaluated. For a full understanding of the modeling outcomes, please review the individual simulation products released to the respective local Environmental Scientist's, or Mr. Mike Schommer in OSPR's Fairfield office. It is a safe statement that following this initial effort, all of the sites are worthy candidates to re-evaluate utilizing alternative strategies and/or environmental parameters in an effort to refine our understanding of variables that influence the success or failure of potential protection strategies, before oil actually threatens them. This iterative process

has great potential to guide a collective effort to improve the reliability of planned protection strategies when combined with actual field test evaluation.

Humboldt Bay

The Humboldt Bay protection strategy simulation involved the evaluation of five separate boom deployment components in the upper bay region near Arcata Bay and Indian Island, along with skimmers at two of the boom locations. The spill scenario involved an instantaneous release of 20,000 gallons of marine diesel from the Shell Oil terminal. The original physical parameters provided to the modelers resulted in the oil moving to the east side of the bay under the pressure of wind, and moving north and south along the shoreline under tidal influence. The modelers then adjusted the wind and tide to provide conditions that would allow the oil to move towards the prescribed protection strategies. Those adjustments indicated that some of the oil would indeed be contained and some successful skimming would likely result. But, a portion of the oil would also entrain and move further north into the bay on the continuing flood tide, then reverse direction and move southward on the later ebb tide. These results suggest that the Area Committee could likely develop testable strategy modifications that would enhance protection efforts.

Bolinas Lagoon

Bolinas Lagoon was selected as a simulation exercise as a consequence of the *Cosco Busan* oil spill response, and the disastrous outcome of the failed protection effort there. Although the *Cosco Busan* response effort failed to employ the protection strategy as described in the San Francisco Area Plan, that plan was modeled for this effort. Since then, a new protection strategy has been developed, and would benefit from this same treatment.

The PISCES model simulation utilized the SF-ACP boom configuration currently described. That strategy describes a combination of boom configuration and skimmer placement. For this exercise the skimmer was disregarded and the four boom components (222.1 (a) and (b), 222.2, 222.3 and 222.5) were evaluated. It was noted that during inquiry testimony following the *Cosco Busan* incident Barry McFarland of the O'Brian Group noted that it was previously known that the Bolinas Lagoon outer bay boom component (222.3) would not work. The simulation model agreed with that assessment. Similarly, the remaining boom configuration is also unlikely to function as planned. The simulation model indicates that oil will enter into the back reaches of Bolinas Lagoon as the strategies are presently configured. Thus, the entire Bolinas Lagoon combination of strategies are ripe for reconsideration, and a likely first candidate for simulation re-design effort in the future.

Elkhorn Slough

The Elkhorn Slough protection strategy simulation involved all of the prescribed boom strategy and skimming equipment presently devised for this location. The intent of this protection strategy is to prevent oil from entering the slough east of the Highway 1 bridge. In the simulation model the strategy was a near complete failure. Of the 17,000 gallons of marine diesel product

released during the several hours of simulated run time, only 4,000 gallons were captured by skimmers. The remaining product entrained beneath the protection booms and proceeded into the slough. This protection strategy would likely benefit greatly from a much more comprehensive evaluation of several alternatives to the present plan.

Morro Bay

The Morro Bay protection strategy simulation evaluated only a single boom placement (4-200.2) although several others are available to evaluate. The spill conditions utilized wind and currents typical for that location, and the release of 1,500 gallons of marine diesel. Three runs of the simulation were exercised utilizing three different release points. The first two release points resulted in the movement of the primary body of oil towards different channel breakwaters and shoreline segments. The third release location resulted in movement of oil along the western boom leg to the apex of the chevron shaped boom protection strategy, where it then began to entrain beneath the boom and proceed into the bay. This site would benefit from additional protection strategy evaluations using other boom placement configurations (currently developed), and possibly varied oil and environmental parameters.

Newport Bay

The Newport Bay protection strategy examined only the single inside boom configuration situated about mid-way into the north/south tending channel. An instantaneous release of 3,000 gallons of red dyed diesel was modeled twice to evaluate the effects of varying tidal velocities. The first run utilizing a 0.5 knot flood tide indicated that the oil would move very obediently along the eastern breakwater and to the boom where it would stop. A second simulation using more dramatic tidal velocity reaching 2.0 knots displayed a very different outcome in which much of the oil would entrain beneath the boom as it migrated along the boom length from the east to the west side of the channel. This site should be re-examined utilizing different boom placement configurations in an attempt to eliminate the observed entrainment associated with higher current velocity. Alternative boom placements should be contemplated.